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Recent performance results of the National Ignition Facility Beamlet demonstration project (*)

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The Department of Energy has started the initial design of a National Ignition Facility (NIF) that will be used to conduct laser driven Inertial Confinement Fusion experiments with the goal of achieving ignition and propagation of thermonuclear fusion burn. The NIF driver will be a Nd-glass laser consisting of 192 individual "beamlets" built into compact arrays, each containing as many as 8 of these beamlets. Each beamlet is a square 36 cm by 38 cm aperture amplifier chain using a four-pass amplifier cavity with a full aperture plasma electrode-Pockels cell, and an additional booster amplifier. Each beam is frequency tripled to 357 nm before being focused in the center of the NIF target chamber.

A full scale, single-aperture scientific prototype of the NIF design, called Beamlet, has been operated at LLNL since 1993. The goal of the Beamlet is to demonstrate the laser science and technology of the NIF architecture. During its initial activation, we demonstrated the successful operation of the 4-pass amplifier cavity using 2x2 segment amplifier units and a large aperture Pockels cell at high fluence (>16.5 J/cm^2 in a 10 ns pulse), with efficient (80%) frequency tripling of the beam to 3ω (351 nm) in a Type I (KDP)/Type II (KD*P) frequency converter. A large vacuum vessel was installed and activated to focus the full 3ω beam using a square wedged lens, simulating a section of the target chamber. Prototype high fluence 1ω transport mirrors, located between the laser and the final optics, have been installed and tested. The 3ω focal plane (target) irradiance was characterized with and without smoothing by a kinoform phase plate using a precision diagnostic system.

We will also report detailed beam propagation and modulation experiments in the Beamlet laser chain and final optics, as described above, aimed at investigating conditions where small scale self-focusing or optical damage becomes a limiting factor. To confirm our understanding of the relation between optical component specifications and laser performance, Beamlet results were compared to propagation models that include individual component performance characteristics, such as phase maps, and gain and loss distributions.

The performance and reliability of individual components, as well as the overall Beamlet laser performance will be reviewed and compared to NIF components and performance requirements.

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